



US006304637B1

(12) **United States Patent**
Mirashrafi et al.

(10) **Patent No.: US 6,304,637 B1**
(45) **Date of Patent: Oct. 16, 2001**

(54) **METHOD AND APPARATUS FOR ESTABLISHING AND FACILITATING A DIRECT QUALITY VOICE CALL TO A TELEPHONE EXTENSION ON BEHALF OF A CLIENT COMPUTER**

5,327,486 7/1994 Wolff et al. 379/93.23
5,390,169 2/1995 Bernstein 370/339
5,526,353 * 6/1996 Henley et al. 370/392

(List continued on next page.)

FOREIGN PATENT DOCUMENTS

0 581 087 A1 7/1992 (DE) .
97/26749 1/1997 (WO) .

OTHER PUBLICATIONS

Telephony Gateway White Paper, "VocalTec Telephony Gateway," <http://www.vocaltec.com>, pp. 2-9; © 1993-1996.

"Microlegend SS7 Tutorial: What is SS7?," <http://www.microlegend.com/whats7.html>, pp.1-3, last update May 25, 1997.

"Microlegend SS7 Tutorial: Message Transfer Part", <http://www.microlegend.com/mtp.html>, pp. 1-5, last update Jun. 9, 1997.

"Microlegend SS7 Tutorial: ISDN User Part", <http://www.microlegend.com/isup.html>, pp. 1-3, last update Jun. 10, 1997.

(List continued on next page.)

Primary Examiner—Allan Hoosain

(74) *Attorney, Agent, or Firm*—Columbia IP Law Group, PC

(57) **ABSTRACT**

An apparatus is comprised of a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services for establishing and supporting a direct quality voice call to a public switched telephone network (PSTN) extension, and an execution unit, coupled to the storage medium, for executing the plurality of programming instructions. In particular, the set of communication services include services for establishing and facilitating the voice call to the PSTN extension on behalf of the client computer, and services for causing a direct connection to be established between the client computer and the apparatus.

18 Claims, 8 Drawing Sheets

(75) Inventors: **Mojtaba Mirashrafi**, Portland; **Ken Pawlak**, Beaverton; **John D. Elliott**, Portland; **Michael F. Buondonno**, Beaverton; **Kenneth L. Keeler**, Hillsboro, all of OR (US); **Keith A Pirkl**, Vancouver, WA (US); **Al J. Simon**, Hillsboro, OR (US); **George L. Taylor**, Tigard, OR (US); **Mark D. Zuber**, Beaverton, OR (US); **Jeffrey B. Sponaugle**, Hillsboro, OR (US)

(73) Assignee: **ITXC, Inc.**, Beaverton, OR (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **08/818,321**

(22) Filed: **Mar. 14, 1997**

(51) **Int. Cl.**⁷ **H04M 1/64; H04M 11/00**

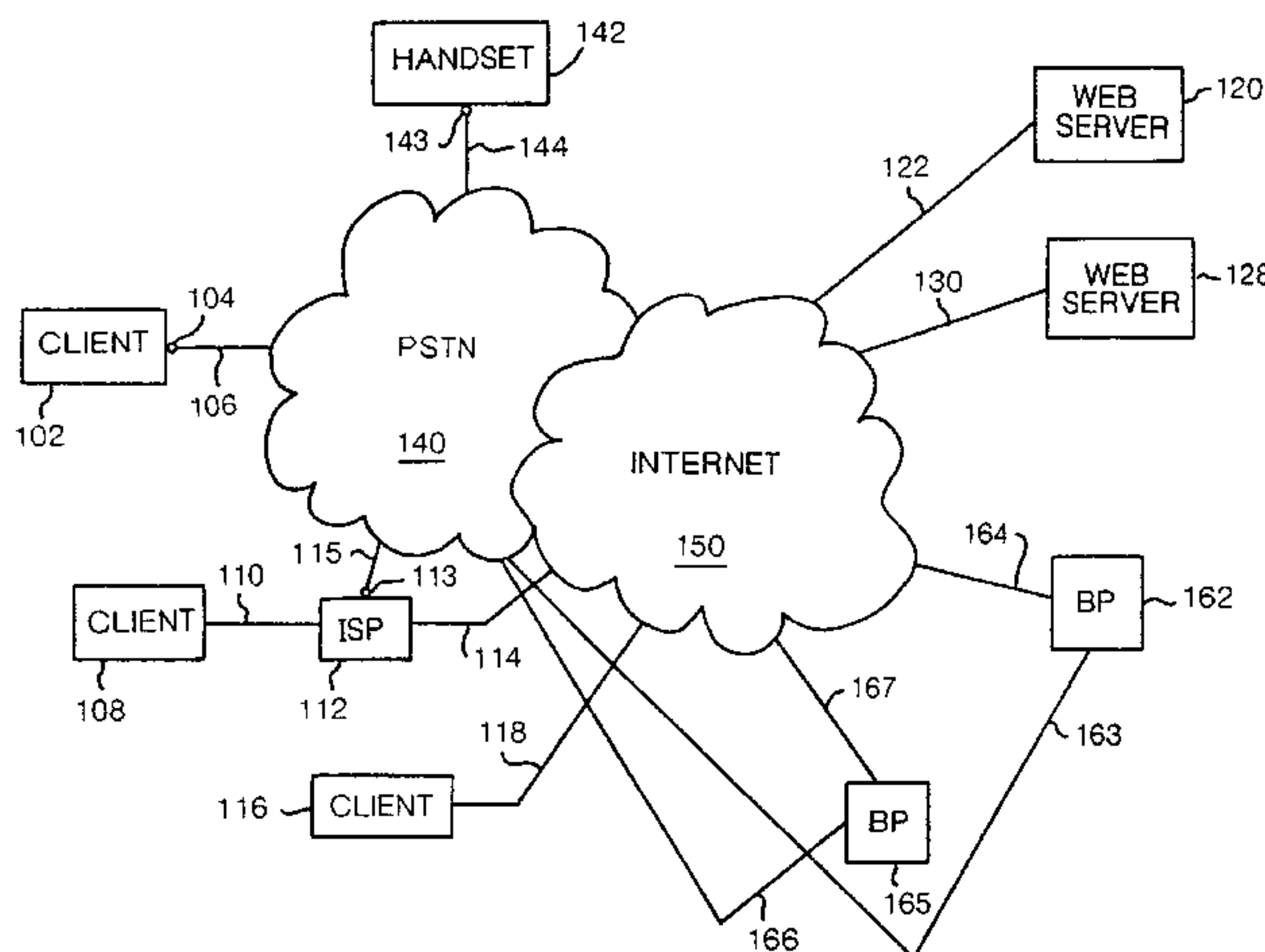
(52) **U.S. Cl.** **379/88.17; 379/88.01; 379/93.09; 379/100.15; 379/900**

(58) **Field of Search** 370/356, 351, 370/352, 389, 401, 466, 70.1, 265, 410; 379/268, 269, 270, 272, 273, 88.01, 88.02, 88.03, 88.17, 88.19, 88.2, 88.21, 93.08, 93.09, 100.15, 210-212, 221, 223, 243, 260, 265, 900, 901, 902, 338, 343; 455/423, 450, 452, 455

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,747,130 * 5/1988 Ho 379/269
4,771,425 9/1988 Baran et al. 370/458
4,866,704 9/1989 Bergman 370/452
5,133,004 * 7/1992 Heileman, Jr. et al. 379/67.1



U.S. PATENT DOCUMENTS

| | | | |
|-----------|-----------|---------------------|-------------|
| 5,539,884 | 7/1996 | Robrock, II | 395/200.57 |
| 5,546,452 | 8/1996 | Andrews et al. | 379/219 |
| 5,553,063 | 9/1996 | Dickson | 370/294 |
| 5,583,920 | 12/1996 | Wheeler, Jr. | 379/88.01 |
| 5,608,446 | 3/1997 | Carr et al. | 348/6 |
| 5,608,786 | * 3/1997 | Gordon | 379/100 |
| 5,610,910 | * 3/1997 | Focsaneanu et al. | 370/351 |
| 5,644,632 | * 7/1997 | Ardon | 379/220 |
| 5,661,790 | * 8/1997 | Hsu | 379/209 |
| 5,694,454 | * 12/1997 | Hill et al. | 379/58 |
| 5,696,760 | 12/1997 | Hardin et al. | 370/252 |
| 5,729,594 | * 3/1998 | Klingman | 379/93.12 |
| 5,742,596 | 4/1998 | Baratz et al. | 370/356 |
| 5,751,706 | * 5/1998 | Land et al. | 370/352 |
| 5,764,736 | * 6/1998 | Shachar et al. | 379/93.09 |
| 5,790,548 | * 8/1998 | Sistanizadeh et al. | 370/401 |
| 5,838,682 | * 11/1998 | Dekelbaum et al. | 370/358 |
| 5,883,891 | * 3/1999 | Williams et al. | 370/358 |
| 5,884,032 | * 3/1999 | Bateman et al. | 3395/200.34 |
| 5,917,817 | * 6/1999 | Dunn et al. | 370/352 |
| 5,940,598 | * 8/1999 | Strauss et al. | 395/200.79 |
| 5,960,073 | 9/1999 | Kikinis et al. | 379/265 |
| 5,995,606 | * 11/1999 | Civanlar et al. | 379/201 |
| 5,995,615 | 11/1999 | Miloslavsky | 379/265 |
| 6,014,379 | * 1/2000 | White et al. | 370/389 |

OTHER PUBLICATIONS

“Microlegend SS7 Tutorial: The SS7 Protocol Stack”, <http://www.microlegend.com/stack.html>, pp. 1–2, last update May 23, 1997.

“Microlegend SS7 Tutorial: Signaling Connection Control Part”, <http://www.microlegend.com/sccp.html>, p. 1, last update May 23, 1997.

“Microlegend SS7 Tutorial: Transaction Capabilities Application Part”, <http://www.microlegend.com/tcap.html>, pp.1–2, last update May 23, 1997.

“Frequently Asked Questions–Technical Support FAQ’s,” What is Net2Phone, <http://www.net2phone.com/tech-faq.html>, pp. 2–8.

Net2Phone Info, <http://www.net2phone.com/ninfo.html>, p. 1, printed Dec. 17, 1996.

“Welcome to the Vicinity Corporation Home Page,” <http://www.vicinity.com>, pp. 2–3, 1996.

“Atlas Telecom Delivers New Enhanced Services Platform Based on Natural MicroSystems Open Telecommunications Technology,” http://www.nmss.com/nmsweb/288a_1f6.html, Nov. 5, 1996.

Telephony Services Architecture: “Natural Platforms,” http://www.nmss.com/nmsweb/2486_1e6.html, 1996.

Natural Platforms: AG–T1 Datasheet “24 Ports of Voice Processing, an integrated T1 Interface, and Natural Media Options,” http://www.nmss.com/nmsweb/22b6_1c6.html, 1996.

“IDT Unveils Net2Phone Direct a COMDEX,” IDT Press Release, [http://www.idt.net/Nov. 21, 1996.html](http://www.idt.net/Nov.21.1996.html), pp. 1–2, 11–21–96.

Abstract, “SET: Bellcore Specification of Signaling System No. 7 (SS7),” <http://www.bellcore.com>, p. 1, 1996.

Abstract, “Bellcore Specification of Signaling System No. 7 (SS7),” <http://www.bellcore.com>, pp. 1–2, 1996.

“Internet Telephones,” PC Magazine, pp. 107, 108, 110, 114, 117, 118, 119, 120; Oct. 8, 1996.

Hill, Jon, “Net2Phone Makes the Call,” PC Magazine, p. 58, Oct. 22, 1996.

“IDT Unveils Full–Duplex Version of Net2Phone,” IDT Press Release, [http://www.idt.net/11–8–96.html](http://www.idt.net/11-8-96.html), pp. 1–2, Nov. 8, 1996.

“Advanced Intelligent Internet,” <http://www.genesyslab.com/genesys/press/archived/ainn.html>, Genesys Publications, Dec. 13, 1995 and Jan. 10, 1996.

“IDT Releases Net2Phone Commercial Version Three Months Ahead of Schedule,” IDT Press Release, [http://www.idt.net/8–5–96.html](http://www.idt.net/8-5-96.html), pp. 1–3, Aug. 5, 1996.

“SoundXchange interActive,” SoundXchange, <http://www.iact.com>, pp. 1–5, Aug. 9, 1996.

* cited by examiner

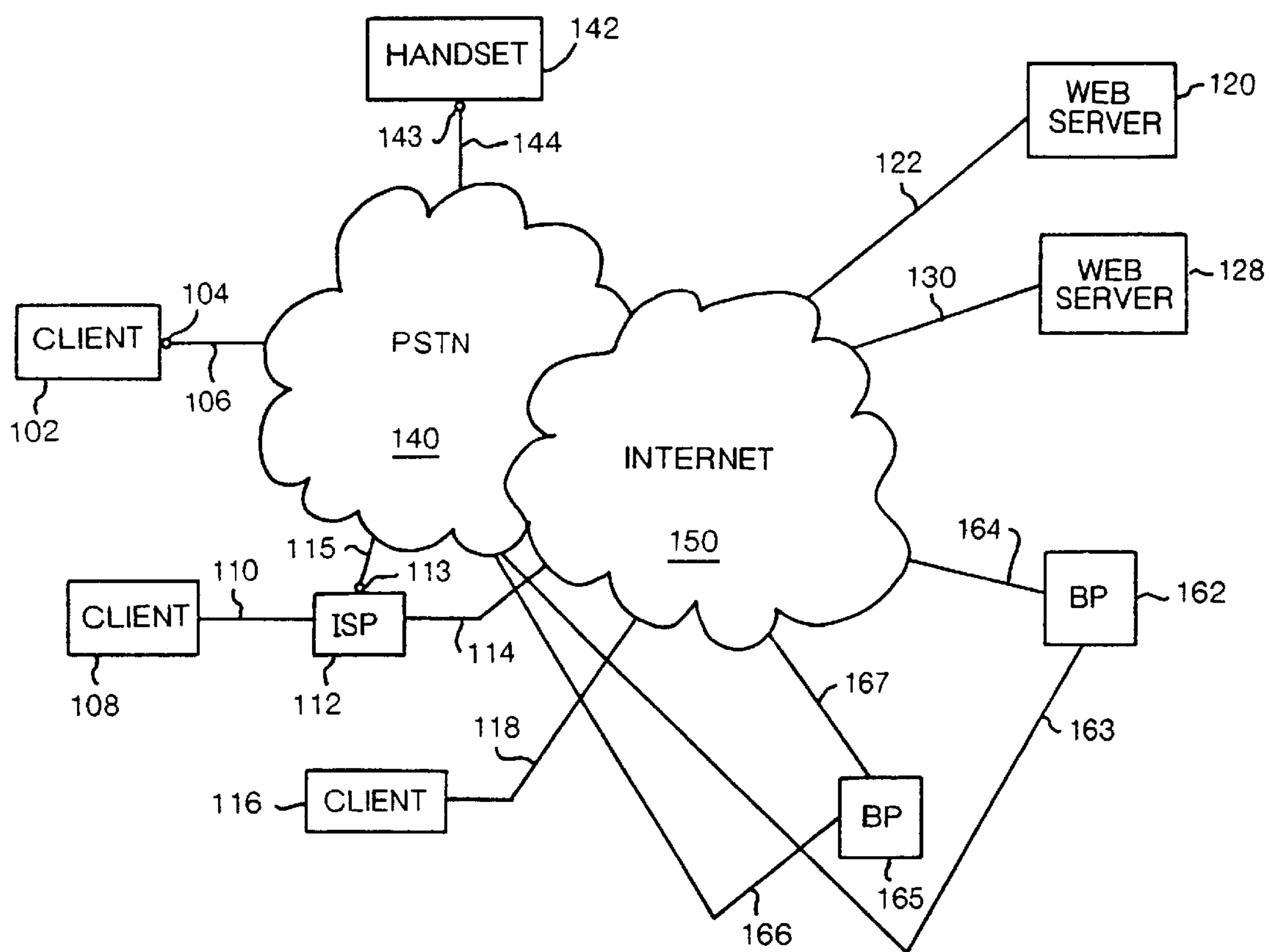


FIG. 1

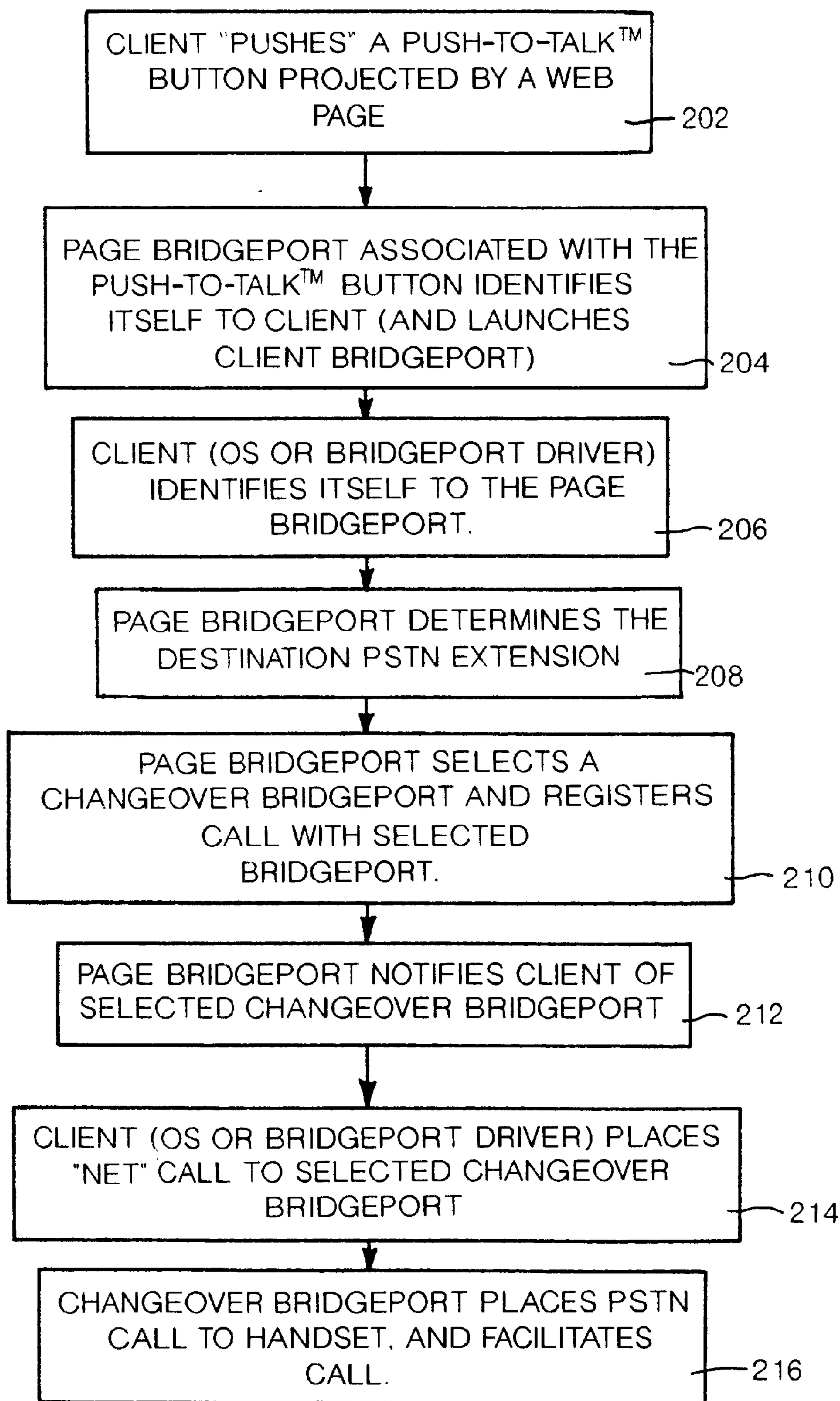


FIG. 2A

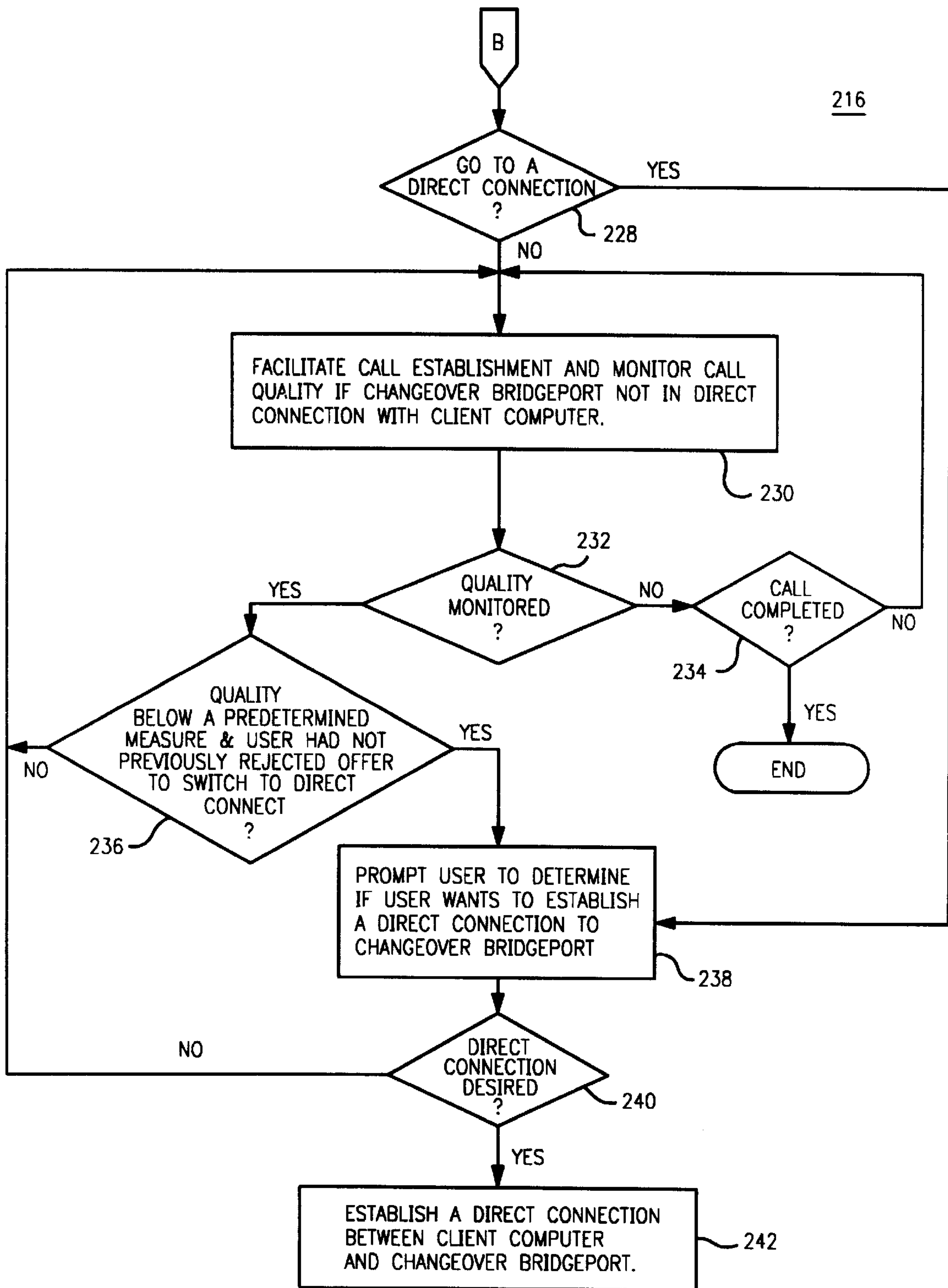


FIG. 2B

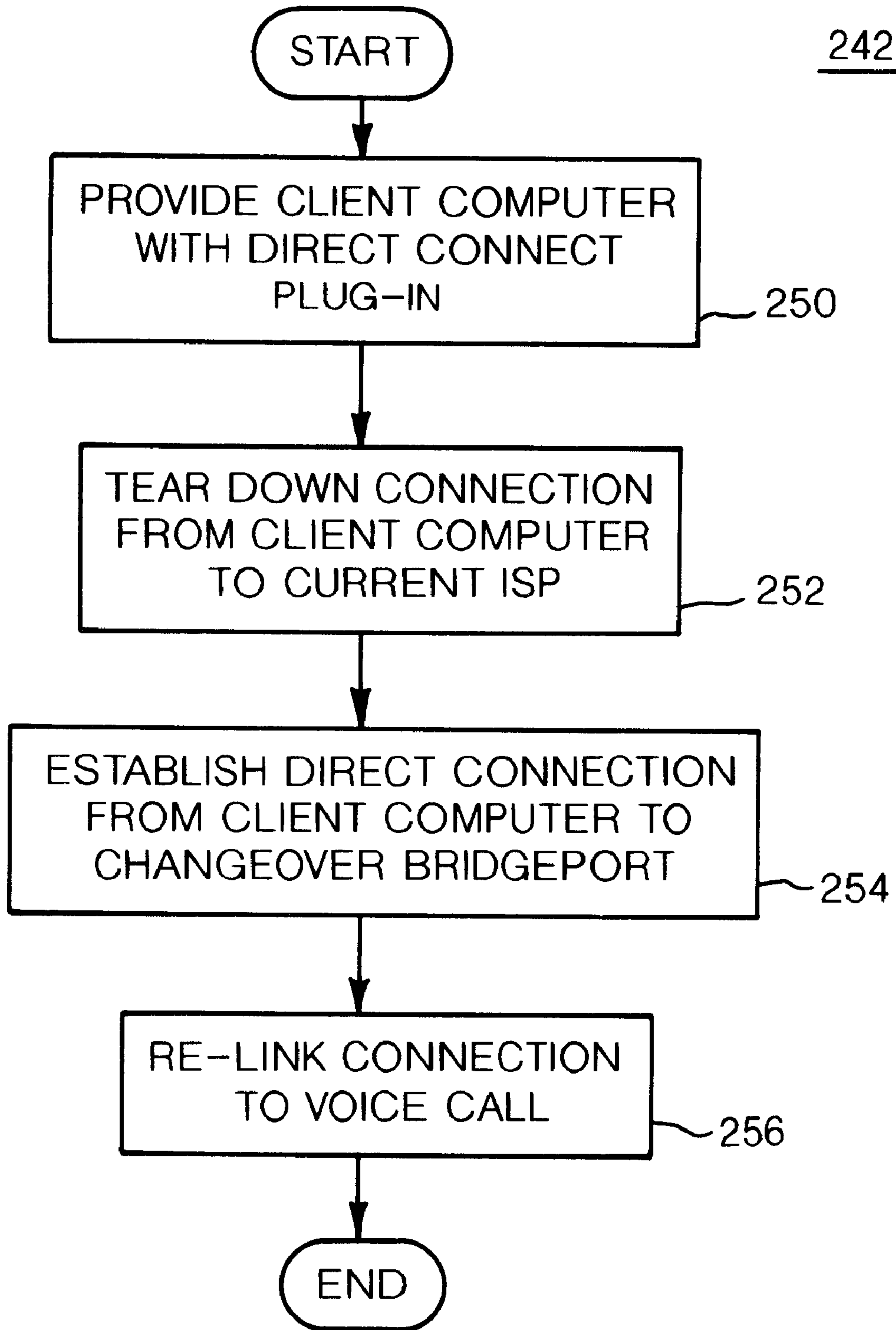


FIG. 2C

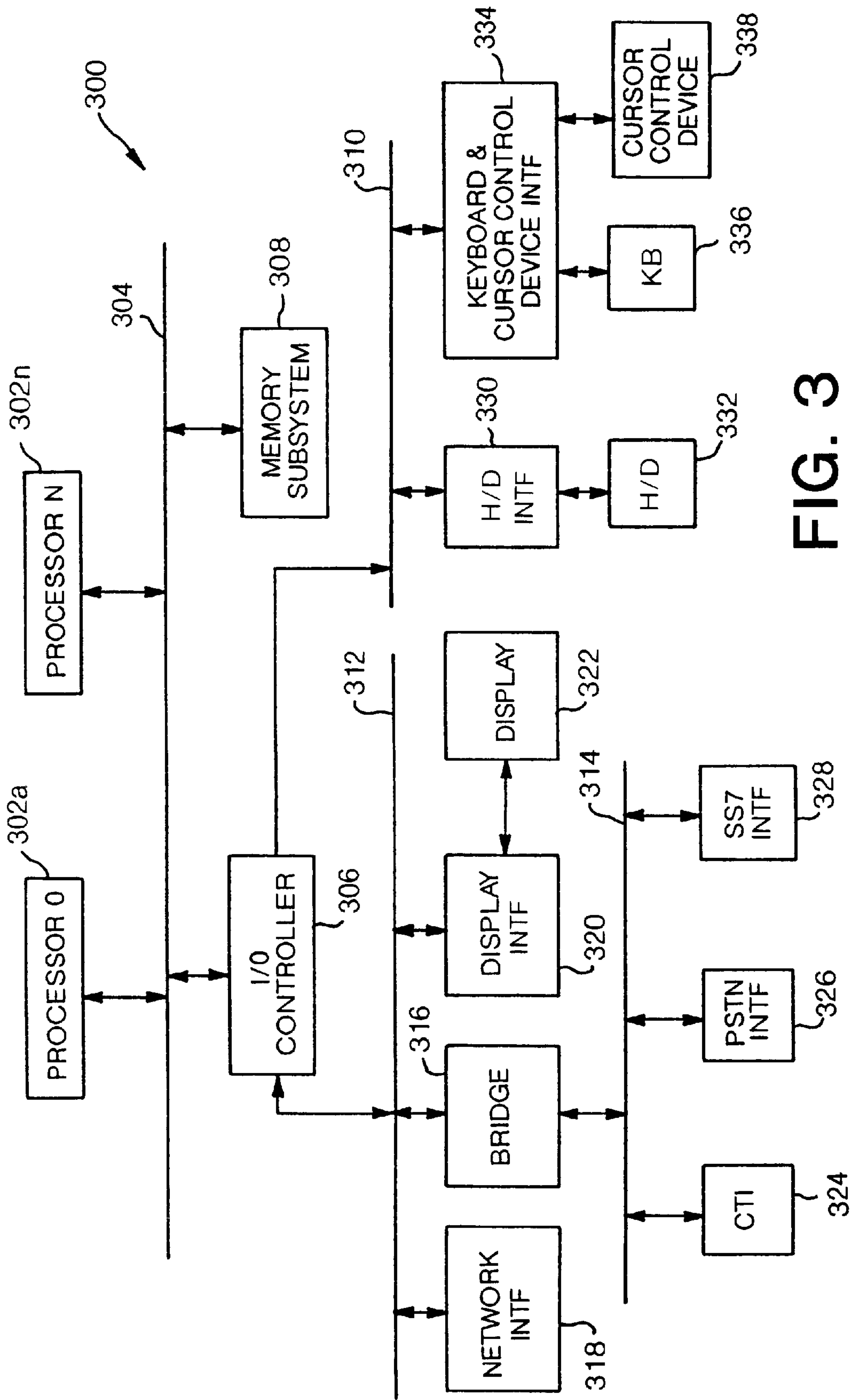


FIG. 3

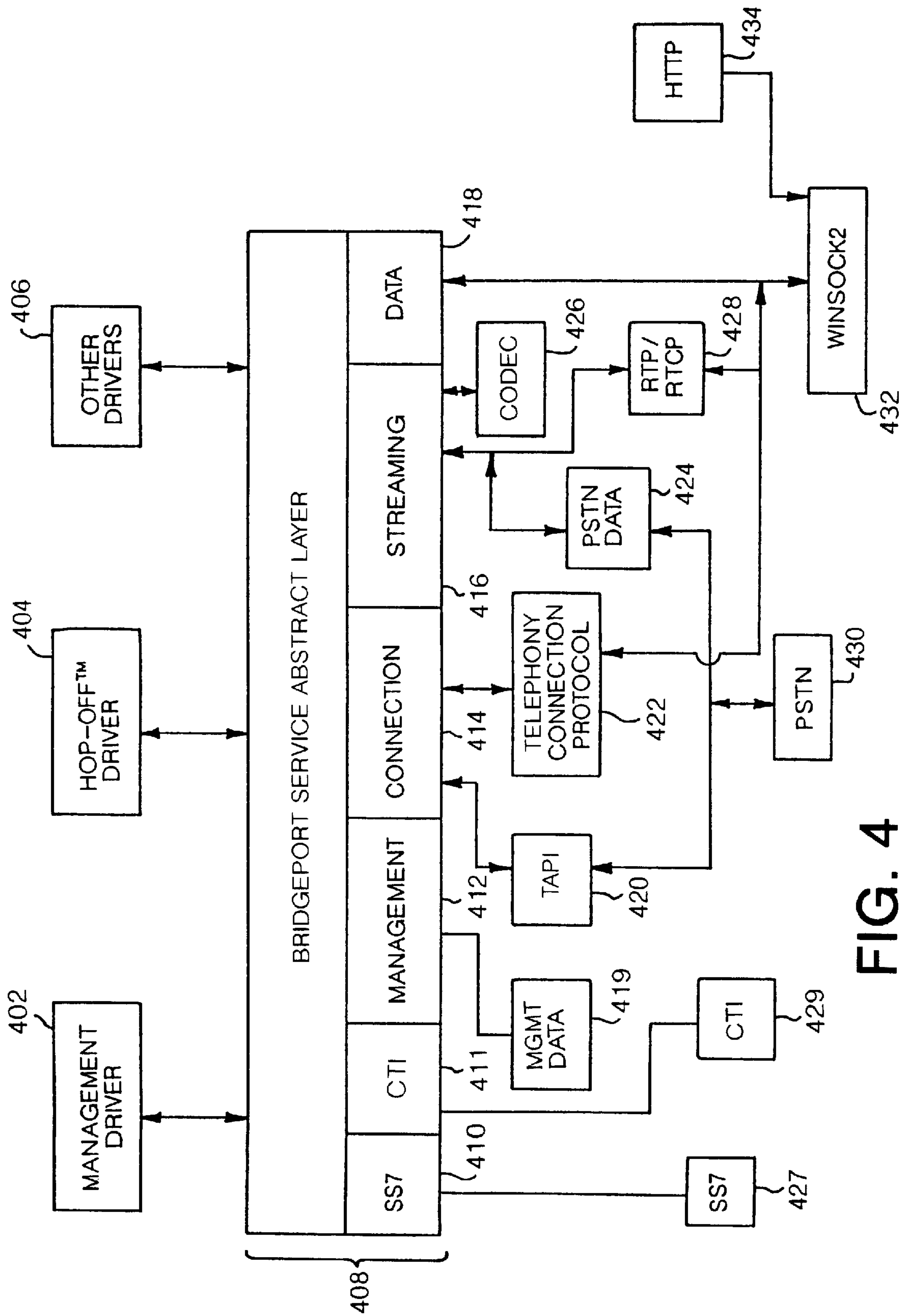


FIG. 4

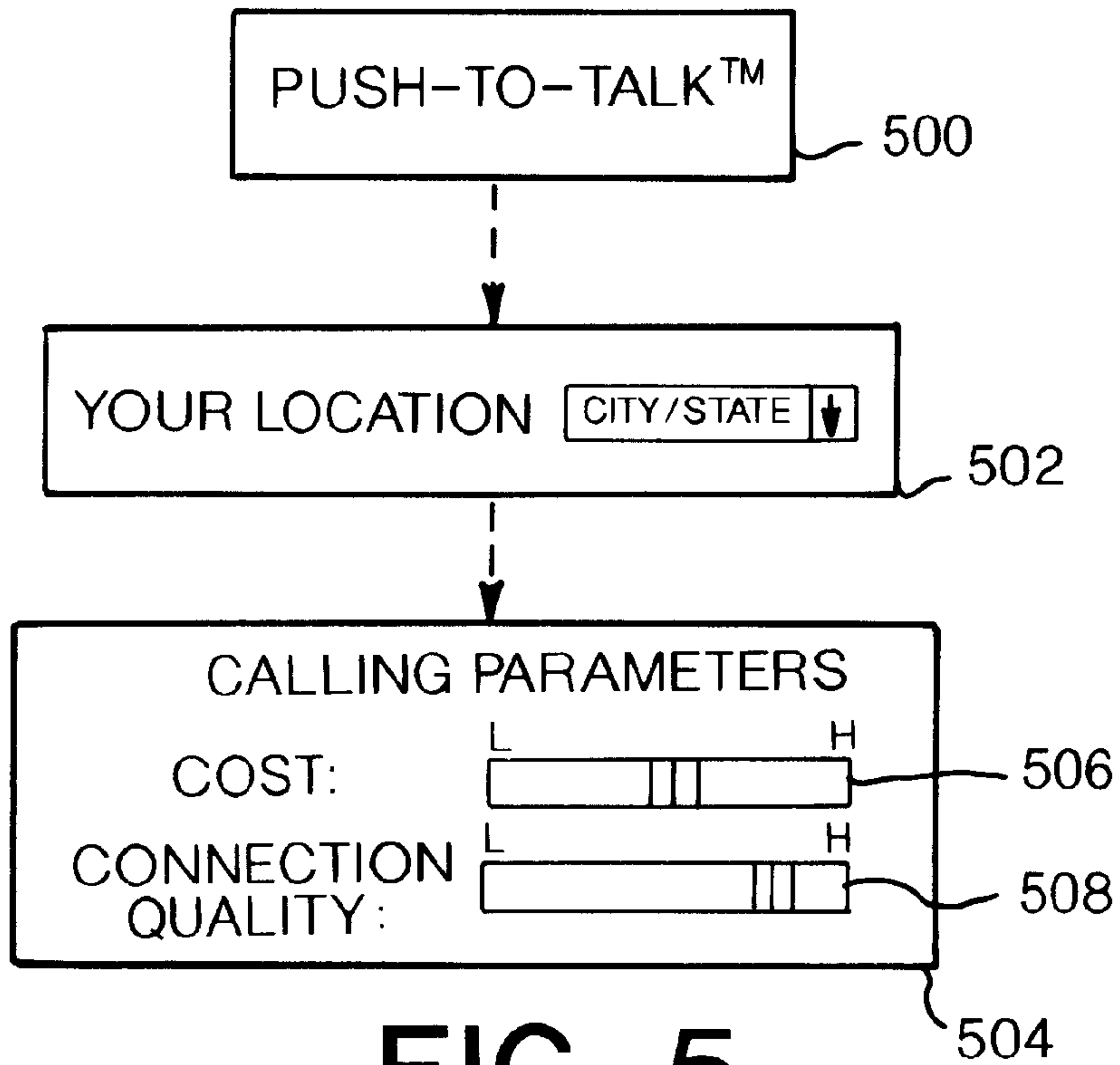


FIG. 5

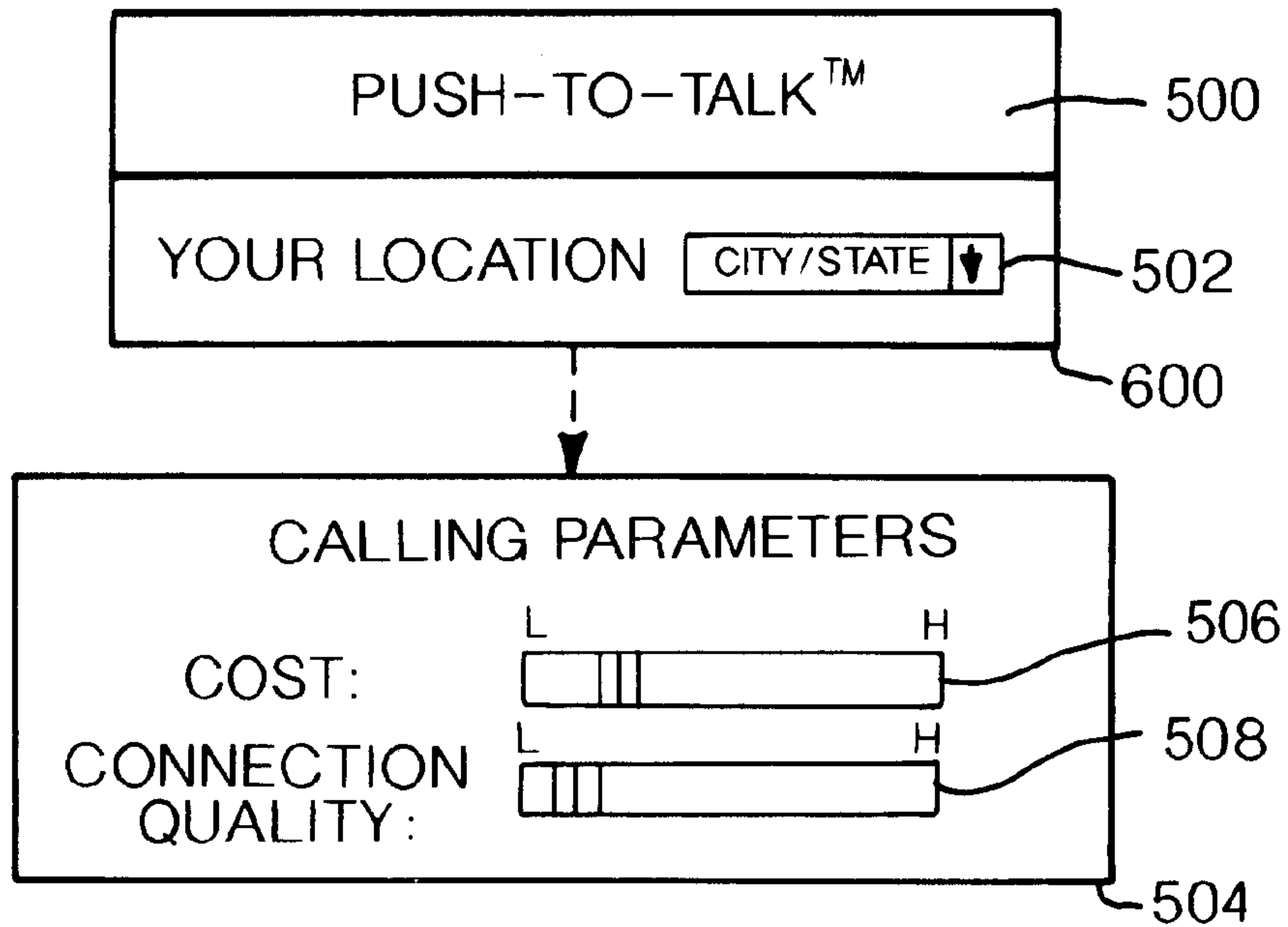


FIG. 6

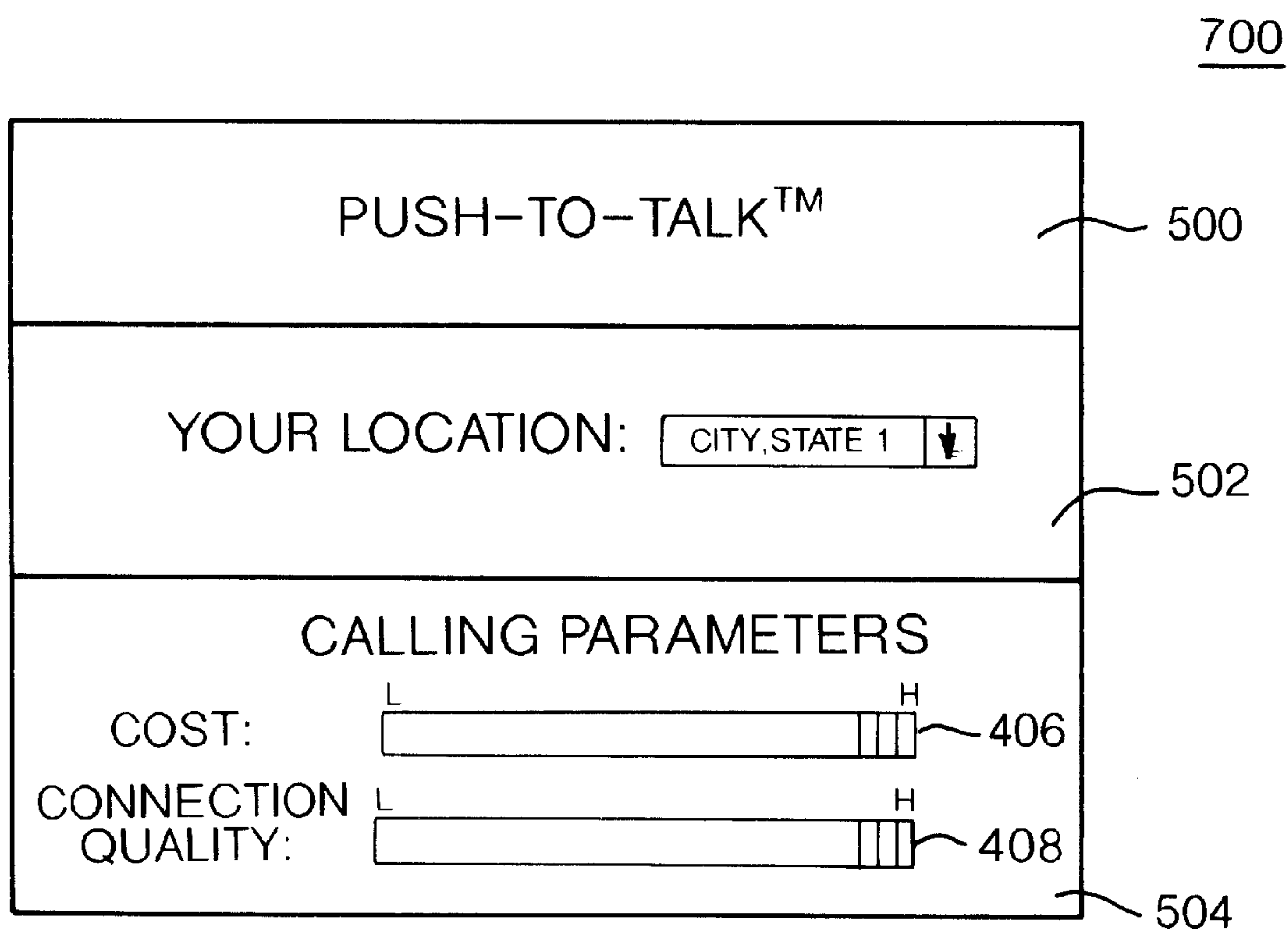


FIG. 7

**METHOD AND APPARATUS FOR
ESTABLISHING AND FACILITATING A
DIRECT QUALITY VOICE CALL TO A
TELEPHONE EXTENSION ON BEHALF OF A
CLIENT COMPUTER**

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to the field of telecommunications and, in particular, to a method and apparatus for establishing and facilitating a direct quality voice call to a telephone extension on behalf of a client computer.

2. Background Information

Numerous advances have been made in recent years in the field of telecommunications. In particular, the field of internet telephony has emerged as a viable technology that is evolving at an ever increasing rate. Evidence of this evolution of internet telephony is best characterized by the number of new products recently become available in the market. Products such as CoolTalk by Netscape Communications Corporation of Mountain View, Calif.; Internet Connection Phone by International Business Machines of Amonk, N.Y.; Intel Internet Phone (IPhone) by Intel Corporation of Santa Clara, Calif.; NetMeeting by Microsoft Corporation, Redmond, Wash.; Quarterdeck WebTalk by Quarterdeck Corporation of Marina Del Rey, Calif.; TeleVox by Voxware Incorporated of Princeton, N.J.; and WebPhone by Netspeak Corporation of Boca Raton, Fla., are representative of the current state of applications facilitating internet telephony.

Each of these products offers internet based voice communications with a telephone motif, between two users each using the same (or compatible) product on either end of the Internet connection. That is, the Internet provides the "switching" architecture for the system, while the computer acts as the "handset", or the audio interface. One reason for the proliferation of these applications is a desire to push the technology of the internet to provide a total communications tool. The appeal to users is that, currently, the use of the Internet is free of toll charges. Therefore, currently, a user of an internet phone product may communicate with another user located anywhere else in the world without having to pay the long distance charges associated with making a telephone call using the public switched telephone network (PSTN).

However, consumers expecting to completely eliminate their long-distance telephone bills through the exclusive use of internet telephony are in for a disappointment. As they shall soon discover, although innovative in their own right, the current internet based telephony applications identified above have a number of limitations which retard their acceptance as a primary communications tool. One such limitation is that many of the applications identified above require that both users have installed the same software package, or compatible packages and, therefore, provide a relatively low level of interoperability. One reason for this lack of interoperability between internet telephony applications is that the developers of many of these products have incorporated different voice encoders (commonly referred to as a "voice codec", or simply a "codec" by those in the telecommunication arts) in the products. Consequently, as a result of the different codecs used, many internet telephony applications are unable to recognize speech encoded (i.e., digitized) by a codec of a dissimilar application.

This problem is alleviated for those products that are upgraded to comply with emerging telephony standards,

such as International Telecommunication Union's (ITU) H.323 standard. However, other limitations remain. For example, another limitation associated with many of these products is that they are tied to the internet, often requiring all users to access a common server in order to maintain a directory of available users in which to call. That is to say, many of the applications identified above do not integrate the packet switched network of the internet with the circuit switched public switched telephone network (PSTN). Therefore, although a computer connected to the internet may communicate with another user on the internet, assuming they are both using a common software application (or at least applications with compatible codecs), these applications do not support communication with a user of a Telephone handset.

The reason for this limitation is readily understood by those who appreciate the complexity of the two networks. As alluded to above, the internet is a packet switched network. That is to say, communication over the internet is accomplished by "breaking" the transmitted data into varying-sized packages (or "packets"), based primarily on communication content, and interleaving the various-sized packages to best utilize the bandwidth available at any given time on the internet. When the packets reach their intended destination, they must be reassembled into the originally transmitted data. Loss of packets, and thus data, occur frequently in such a network, and the ability of the network to successfully transmit information from one point in the network to another determines the quality of the network. For inter-computer communication transactions involving non real-time data, the ability to transmit packets and retransmit any packets that are perceived to have been dropped is not a severe limitation and may not even be perceived by the user of the system. However, in a voice communication transaction, the delay required to retransmit even one data packet may be perceived by a user. At best, such delays are an annoying inconvenience. In practice, the delays actually can become intolerable, as the cumulative latency adds up with successive transmissions.

In contrast to the packet switched network of the internet, the public switched telephone network (PSTN) is a circuit switched network. That is to say that the PSTN assigns a dedicated communication line to a user with which to complete the telephone call, wherein the user can utilize the assigned resource of the PSTN in any way they choose, with the understanding that the user is paying for the use of the dedicated resource of the PSTN. While the circuit switched approach of the PSTN system is not necessarily the most efficient system in terms of call traffic (i.e., it does not make use of the "dead space" common in a conversation), it is relatively easy to ensure that information destined for a particular user is delivered, it simply provides a dedicated line to complete the transaction.

Nonetheless, despite these engineering challenges, a few products have emerged which purport to integrate the PSTN to the internet. Products such as Net2Phone by IDT Corporation of Hackensack, N.J., claim to provide a computer user with the ability to place and receive a phone call to/from a PSTN extension. Unfortunately, none of these products completely solve the problem of integrating the two networks. The limitations perhaps best characterized by way of an example communication session. With these prior art internet telephony applications, a user of an internet telephony enabled client computer initiating a telephone call to a Telephone handset launches the voice call from the client computer by accessing a server (the primary access server), operated by the developer of the internet telephony appli-

cation that supports internet telecommunications. As the initiator accesses the primary access server, he/she is prompted for a destination address, which takes the form of a PSTN telephone number for an outgoing call to a Telephone handset. Having provided the primary access server with the PSTN telephone number associated with the Telephone handset, the primary server somehow determines which server in a community of similarly enabled servers (i.e., servers with the hardware/software necessary to provide access to the PSTN) is closest to the destination address, and completes the telephone call by routing the telephone call through a number of intermediate servers on the internet to the selected server, which will actually place the voice call to the Telephone handset on behalf of the client computer, facilitating the voice call between the client computer and the Telephone handset. In other words, the user of the client computer is required to have prior knowledge of the destination phone number, which is limiting in many circumstances. For example, in a situation where the user of the client computer is engaged in a data communication session involving a webpage for a corporate entity, the user may wish to speak with someone in a "local office" of the corporate entity. Prior art internet telephony applications require that the telephone number for the "local office" of the corporate entity be provided by the user of the client computer in order to place the telephone call. If the telephone number for the "local office" of the corporate entity is not provided by the webpage, the user of client computer must look it up or have prior knowledge of it.

¹The manner in which the "primary access server" determines the "call originating server" is not known.

Additionally, while the prior art approach of simply finding the Internet telephony enabled server closest to the destination address may offer the simplest technical solution and a seemingly cheaper connection, it does not ensure the quality of the voice connection. One skilled in the art will appreciate that there are a number of characteristics which may impact the quality of the voice connection. For example, insofar as the internet is a packet switched network, as the number of intermediate routers required to interface the client computer to the selected server increases so, too, does the likelihood that data packets containing voice information could be lost or corrupted. The result of lost or corrupted data packets is broken or garbled speech. Another factor affecting internet telephony communication performance is the bandwidth available on the selected server. If, for example, the selected server is very busy handling a number of other processes, the performance associated with each of the processes begins to degrade (i.e., slow down), which may also result in delayed delivery of data packets containing speech, which in turn results in user perception of poor quality. Therefore, while it is important to some users of internet telephony applications to simply keep the cost down, quality considerations must also be accounted for to enable internet telephony to evolve into a viable communications tool.

Thus, a need exists for a method and apparatus for establishing and facilitating a direct quality voice call to a telephone extension on behalf of a client computer, that is unencumbered by the limitations associated with the prior art.

SUMMARY OF THE INVENTION

In accordance with the teachings of the present invention, a method and apparatus for establishing and facilitating a direct quality voice call to a telephone handset on behalf of a client computer is provided. In a first embodiment, for

example, the apparatus comprises a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services for establishing and facilitating the direct quality voice call, and an execution unit, coupled to the storage medium for executing the programming instructions. The set of communication services include, for example, services for establishing and facilitating the voice call from the client computer to a PSTN extension, and services for causing the direct connection to be established between the client computer and the apparatus, as appropriate.

In one embodiment, the services for causing the direct connection to be established include services for providing the client computer with a software that automatically replaces an established connection between the client computer and a network server, with the direct connection between the client computer and the apparatus.

In one embodiment, the set of communication services include services for seeking the client computer's concurrence to establish the direct telephone connection between the client computer and the apparatus. In one embodiment, the client computer's concurrence is sought dynamically in the middle of a pre-direct connection phase of the voice call, at the discretion of the apparatus. In alternate embodiments, the client computer's concurrence is sought at the beginning of the voice call, at the discretion of the apparatus, another apparatus, or at the discretion of the web server which offers a Push-To-Talk^{TM2} feature to the client computer.

²Push-To-TalkTM is a Trademark of eFusionTM, Incorporated of Beaverton, Oreg.

In one embodiment, the decision of whether to establish a direct connection between the client computer and the apparatus is initiated as a result of monitoring voice call quality. In one embodiment, the apparatus monitors any number of quality metrics associated with voice call quality. In one embodiment, the apparatus establishes a direct connection, with the concurrence of the client computer, due to the number of intermediate servers between the client computer and the apparatus. In one embodiment, a second apparatus instructs the apparatus, with the concurrence of the client computer, to establish a direct connection between the client computer and the apparatus due to the number of intermediate servers between the client computer and the apparatus. In another embodiment, a web server instructs the apparatus, with the concurrence of the client computer, to establish a direct connection between the client computer and the apparatus. In other embodiments, a direct connection is established between the client computer and the apparatus, without the concurrence of the client computer, by the apparatus, and optionally at the direction of another apparatus, or the web server. In one embodiment, the direct connection is established by the user of the client computer at the onset of the voice call by, for example, selecting an icon on the desktop of the client computer.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will be described by way of exemplary embodiments, but not limitations, illustrated in the accompanying drawings in which like references denote similar elements, and in which:

FIG. 1 is a block diagram illustrating an exemplary communication system incorporating the teachings of the present invention;

FIGS. 2A and 2B are flow charts illustrating one embodiment of a method for establishing a voice communication session between a client computer and a PSTN handset, in accordance with one embodiment of the present invention;

FIG. 2C is a flow chart illustrating one embodiment of a method for establishing a direct connection between the client computer and the exemplary communication system;

FIG. 3 is a block diagram illustrating an exemplary server suitable for use as an internet/PSTN changeover server of the present invention;

FIG. 4 is a block diagram illustrating the software architecture of the exemplary server of FIG. 3, in accordance with one embodiment of the present invention; and

FIGS. 5, 6 and 7 are graphical illustrations of alternate embodiments of Push-To-Talk™ indicators for requesting a voice communication session, suitable for use in the exemplary communication system described in FIGS. 1-4.

DETAILED DESCRIPTION

In the following description, for purposes of explanation, specific numbers, materials and configurations are set forth in order to provide a thorough understanding of the present invention. However, it will be apparent to one skilled in the art that the present invention may be practiced without the specific details. In other instances, well known features are omitted or simplified in order not to obscure the present invention. Furthermore, for ease of understanding, certain method steps are delineated as separate steps, however, these separately delineated steps should not be construed as necessarily order dependent in their performance.

Referring now to FIG. 1, a block diagram is presented illustrating an exemplary communication system 100 incorporating the teachings of the present invention for connecting a user of an internet telephony enabled client computer with a user of a PSTN endpoint (e.g., telephone handset), and routing the voice call off of the internet. While the present invention will be described in the context of this exemplary computer system, based on the descriptions to follow, those skilled in the art will appreciate that the present invention is not limited to this embodiment, and may be also practiced with intranet (in lieu of the internet) and/or automated/computerized telephony answering equipment (in lieu of telephone handsets).

For the illustrated embodiment, client computer 102 incorporated with the teachings of the present invention, while in data communication with a web server, e.g. web server 128, through PSTN 140 and Internet 150, is presented with a Push-To-Talk™ option by web server 128. When client computer 102 selects the Push-To-Talk™ option, a server incorporated with the teachings of the present invention (e.g., bridgeport 162) automatically determines an appropriate destination PSTN extension, e.g. the PSTN extension of telephone handset 142, as well as an appropriate one of a "community" of internet/PSTN changeover servers (e.g., bridgeports 162 and 165) to place the voice call to the PSTN extension and facilitate the voice call between the user of client computer 102 and the user of telephone handset 142. In the context of the example embodiment, for differentiation and ease of explanation, bridgeport 162 will be referred to as a page bridgeport, while the selected internet/PSTN changeover server will be referred to as a changeover bridgeport. In one embodiment, the Push-To-Talk™ option is pre-associated with page bridgeport 162 by web server 128, and the determination of the destination PSTN extension by page bridgeport 162 is made in accordance with one or more attributes of web server 128, such as the identity of web server 128, and optionally, one or more attributes of client computer 102, such as the zip code of the geographic area client computer 102 is located. In an alternate embodiment, page bridgeport 162 is not pre-

associated with the Push-To-Talk™ option, but rather is selected dynamically by web server 128.

Client computer 102, web servers 120 and 128, bridgeports 162 and 165, and handset 142 are communicatively coupled to each other by way of PSTN 140 and internet 150 as shown. More specifically, client computer 102 is coupled to internet 150 by way of a direct connection (e.g., a direct PSTN telephony connection, a direct wireless telephony connection, etc.) to internet service provider (ISP) 112. Client computer 102 is coupled to ISP 112 through PSTN extension 104, communication line 106 and PSTN 140. In other words, for the illustrated embodiment, client computer 102 includes a modulation/demodulation (MODEM) device (not shown) coupled to PSTN extension 104. However, a client computer may be coupled to ISP 112 through a network connection using a network interface instead, such as client computer 108 using network connection 110. Alternatively, a client computer may also be directly coupled to internet 150 such as client computer 116 using direct connection 118.

Web servers 120 and 128 are coupled to internet 150 through connections 122 and 130. Although not illustrated, web servers 120 and 128 may also be coupled to PSTN 140. Similarly, bridgeports 162 and 165 of the present invention are coupled to internet 150 through connections 164 and 167. Bridgeports 162 and 165 are also coupled to PSTN 140 through communication lines 163 and 166 respectively. Handset 142 is coupled to PSTN 140 through PSTN extension 143 and communication line 144.

Communication lines 106, 115 and 144 may simply be plain old telephone service (POTS) communication lines, although other types of communication lines may be used. For example, in the case of communication line 106, it may be an integrated service digital network (ISDN) line, whereas in the case of communication line 115, it may be a T1 (1.533 Mbps) or an E1 (2.0488 Mbps) trunk line. In the case of communication line 144, it may be a wireless cellular connection, a Personal Communication Services (PCS) connection, and the like.

PSTN 140 includes a number of Service Switching Points (SSP), Signal Transfer Points (STP), and Service Control Points (SCP) coupled to each other (not shown). PSTN extension 104 through communication line 106 is coupled to a "local" SSP, which in turn is coupled to a number of other "local" PSTN extensions, including e.g. PSTN extension 113 if ISP 112 is a "local" ISP served by the same SSP. In addition, the "local" SSP is also coupled to an associated STP, which in turn is coupled to other "remote" SSPs. Each of the "remote" SSPs is coupled to a number of "remote" PSTN extensions, including e.g. extension 143, if handset 142 is a "remote" handset served by a "remote" SSP. As is well known in the art, internet 150 includes a number of networks interconnected by routers, interconnecting the various client computers, web servers and bridgeports together. [As described earlier, internet 150 may be a private intranet instead.]

Except for the incorporated teachings of the present invention (to be more fully described below), client computer 102 is intended to represent a broad category of internet telephony enabled computer systems known in the art. An example of such a computer system is a desktop computer system equipped with a high performance microprocessor, such as the Pentium® processor manufactured by Intel Corporation of Santa Clara, Calif. or the Alpha® processor manufactured by Digital Equipment Corporation of Manard, Mass.; a number of audio input and

output peripherals/interface for inputting, digitizing and compressing outbound audio, and for decompressing and rendering inbound audio; a communication interface for sending and receiving various data packets (including audio data packets) in accordance with certain standard communication protocol, such as a V.42bis compliant modem or an Ethernet adapter card; a windows-based operating system including internetworking communication services providing support for Transmission Control Protocol/Internet Protocol (TCP/IP) (and other Internet Communication Suite protocols) and socket services, such as Windows™ 95 developed by Microsoft Corporation of Redmond, Wash.; a web communications tool such as Navigator™, developed by Netscape Communications of Mountain View, Calif.; and an Internet telephony application, such as the above described iPhone™³ developed by Intel Corporation.

³Note that it is not necessary for the internet telephony application to explicitly support voice calls with telephone handsets, as is the case with iPhone and many of the prior art internet telephony applications.

In one embodiment, the teachings of the present invention are incorporated in client computer **102** in the form of a client application. In one embodiment, the application is a “bridgeport driver”. The client bridgeport driver may be made available to client computer **102** in a number of alternate means. For example, the client bridgeport driver may be distributed via diskettes produced by a bridgeport vendor, or downloaded from a web server of the bridgeport vendor. In other embodiments, the teachings of the present invention are incorporated in the browser and/or the operating system (OS) of client computer **102**. For ease of understanding, the remaining descriptions will be presented in the context of the client bridgeport driver embodiment.

Except for the presentation of webpages having Push-To-Talk™ options pre-associated with the bridgeports of the present invention, web servers **120** and **128** are intended to represent a broad category of web servers, including e.g. corporate presence servers and government presence servers, known in the art. Any number of high performance computer servers may be employed as web servers **120** and **128**, e.g. a computer server equipped with one or more Pentium® Pro processors from Intel Corp., running Microsoft’s Windows® NT operating system, or a computer server equipped with one or more SPARC® processors from Sun Microsystems of Mountain View, Calif., running Sun’s Solaris® operating system.

Similarly, ISP **112** is intended to represent a broad category of internet service providers. An ISP may be a “small” local internet access provider, or one of a number of point of presence providers offered by a “large” ISP. It is also anticipated that ISP **112** may be incorporated with an SSP of PSTN **140**. Handset **142** is intended to represent a broad category of conventional handsets known in the art, including but not limited to desktop handsets, cordless handsets, and wireless handsets. No special features are required of handset **142** for it to be called and connected to internet telephony enabled client computer **102**, in accordance with the present invention. [As described earlier, handset **142** may also be automated/computerized telephony answering equipment.]

Before we proceed to describe bridgeports **162** and **165** in further detail, it should be noted that one skilled in the art of, for example, telecommunications, will appreciate that the communication system illustrated in FIG. **1**, is significantly more complex than that which is depicted. For example, each SSP of PSTN **140** may service thousands of PSTN extensions, and there are numerous SSPs, STPs and SCPs in a common PSTN implementation. Internet **150** includes well over several hundred thousand networks. Together, PSTN

140 and internet **150** interconnect millions of client computers and web servers. Nonetheless, FIG. **1** does capture a number of the more relevant components of a communication system necessary to illustrate the interrelationship between client computer **102**, web server **128**, bridgeports **162** and **165**, and handset **142**, such that one skilled in the art may practice the present invention. Also, while the present invention is being described in the context of client computer **102** being engaged in data communication with web server **128**, as will be readily apparent from the description to follow, the present invention may be practiced with any “client” computer engaged in data communication with any “web” or “info” server.

Turning now to FIG. **2A**, a flow chart illustrating one embodiment of the method steps of the present invention for establishing and facilitating a voice call to a PSTN extension for a networked client computer is shown. For ease of explanation, the method of FIGS. **2A–2C** will be developed in the context of an example implementation, wherein a user of client computer **102** is engaged in a data communication session involving a webpage, projected by web server **128**, which incorporates a Push-To-Talk™ feature wherein the user of the webpage may “push” a displayed Push-To-Talk™ button to cause a voice connection with a local office, retail center and the like, associated with the web server, to be established, enabling the user of client computer **102** to engage in a voice call with a user of a PSTN endpoint (e.g., handset **142**) located at the “local office”. [Those skilled in the art will appreciate that the terms “push” and “pushing” are metaphoric descriptions of the action taken by a user. The action is in actuality accomplished, e.g., by the user clicking a mouse button, upon moving a cursor over the displayed Push-To-Talk™ button.]

With reference to FIG. **2A**, the method begins at step **202** with a user of client computer **102** “pushing” the Push-To-Talk™ button projected with the webpage. As described earlier, the Push-To-Talk™ button is pre-associated with a bridgeport, e.g. page bridgeport **162**. In one embodiment, the pre-association is accomplished via HyperText Markup Language (HTML) elements embedded in the webpage, identifying the Uniform Resource Locator (URL) of page bridgeport **162**. The HTML elements further specify that a Push-To-Talk™ event notice including the URL of web server **128** is to be posted to page bridgeport **162**. Thus, in response to the user’s “pushing” of the Push-To-Talk™ button, a HyperText Transmission Protocol (HTTP) connection is temporarily established between client computer **102** and page bridgeport **162**, and a message posting the Push-To-Talk™ event is sent to page bridgeport **162**.

For the illustrated embodiment, in response to the Push-To-Talk™ event notification, page bridgeport **162** identifies itself to client computer **102**, providing client computer **102** with its internet protocol (IP) address, step **204**. The HTTP connection is closed upon sending the return data to client computer **102** by page bridgeport **162**. In one embodiment, the identification and provision of page bridgeport’s IP address also includes identification that the information is associated with a Push-To-Talk™ button projected by web server **128**. More specifically, the URL of web server **128** is also returned to client computer **102**. For the illustrated embodiment, the returned data also includes a command for starting up the client bridgeport driver on client computer **102**.

Next, for the illustrated embodiment, client computer **102** identifies itself to page bridgeport **162**, providing page bridgeport **162** with its IP address and attributes. For the illustrated embodiment, the identification is performed by

the launched client bridgeport driver, by way of another HTTP connection. In one embodiment, the identification is also made in the form of a call request to talk to a person, such as an agent, associated with web server **128**. In one embodiment, the attribute information includes a zip code for the area client computer **102** is located. In another embodiment, the attribute information includes a PSTN extension associated with client computer **102**. In one embodiment, the URL of web server **128** is also re-transmitted.

In response, page bridgeport **162** determines a destination PSTN extension for the requested call, step **208**. In one embodiment, the determination is based on attributes of web server **162**, e.g. the URL or the associated corporate name (if provided) of web server **162**. In another embodiment, the determination is also based on attributes of client computer **102**, e.g. the zip code or the telephone area code/prefix associated with client computer **102**. In one embodiment, page bridgeport **162** is equipped with a PSTN extension database having the necessary attributes and PSIN extension information for performing the determination. In an alternate embodiment, page bridgeport **162** is not equipped with such a PSTN extension database, but equipped with services that access external on-line services (e.g., geographic location services, directory services, etc.) to make the determination. An example of an on-line geographic location service is MapBlast™, developed by Vicinity Corporation of Palo Alto, Calif.

Upon determining the destination PSTN extension, for the illustrated embodiment, page bridgeport **162** selects an internet/PSTN changeover server. In one embodiment, the internet/PSTN changeover server is a bridgeport, such as bridgeport **165** (changeover bridgeport), where the requested voice call is routed off internet **150** and onto PSTN **140**, step **210**. The selection is made from a “community” of bridgeports, to be described more fully below. In one embodiment, the community of bridgeports are “private” bridgeports deployed by the owner of web server **128** (e.g., a corporation). In another embodiment, the community of bridgeports are “public” bridgeports deployed by a service company that offers the bridgeport service of the present invention, and subscribed by the corporation of web server **128**. Note that page bridgeport **162** may select itself as the changeover bridgeport, either because of the selection criteria employed dictate the result, or by virtue of a singleton community, i.e. page bridgeport **162** is the only bridgeport of the “community”. For ease of understanding, the remaining descriptions will be presented in the context of bridgeport **165** being the selected changeover bridgeport.

Upon selecting changeover bridgeport **165**, for the illustrated embodiment, page bridgeport **162** registers the requested call with changeover bridgeport **165**, step **210**. In one embodiment, the registration reserves bandwidth on changeover bridgeport **165** for the requested call. For example, in one embodiment, the registration includes provision of the source IP address of the voice call, i.e. the IP address of client computer **102**, the source type (e.g. H.323), the destination address, i.e. the destination PSTN extension of handset **142**, and the destination type (e.g. POTS).

Next, for the illustrated embodiment, page bridgeport **162** identifies changeover bridgeport **165** to client computer **102**, providing client computer **102** with the IP address of changeover bridgeport **165**, step **212**. In one embodiment, where the call request is made through an HTTP connection, step **212** also includes closing the HTTP connection. In one embodiment, the identification also includes provision of the URL of web server **128**. In one embodiment, both the

identification, i.e. the IP address of changeover bridgeport **165**, and the URL of web server **128** are provided to client bridgeport driver.

Next, for the illustrated embodiment, client computer **102** places a net call to changeover bridgeport **165**, step **214**. In one embodiment, the net call is an H.323 call placed by an internet telephony application. In one embodiment, step **214** also includes automatic launching of the internet telephony application to place the net call, if an internet telephony application has not been previously launched. For the illustrated embodiment, the automatic launching is performed by the client bridgeport driver.

In response, changeover bridgeport **165** places a voice call to the PSTN extension of handset **142**, and bridges the net and the voice calls, step **216**, thereby allowing a user of client computer **102** to communicate with a user of handset **142**. In bridging the two calls, changeover bridgeport **165** digitizes and compresses inbound call signals received from handset **142**, and delivers the encoded call signals to client computer **102** via the previously established H.323 connection. The compressed inbound call signals are decompressed by the communication interface of client computer **102** and rendered by the internet telephony application. Similarly, outbound call signals emanating from client computer **102** are digitized by the audio interface, compressed by the communication interface of client computer **102** and delivered to changeover bridgeport **165** via the H.323 connection, wherein they are decompressed, and upon conversion, forwarded to handset **142**. In other words, changeover bridgeport **165** converts the voice information between PSTN and IP protocols and delivers voice call information to/from handset **142** and client computer **102** until call completion.

With reference now being made to FIG. **2B**, one embodiment of step **216** is illustrated. As the H.323 connection between client computer **102** and changeover bridgeport **165** is established, changeover bridgeport **165** determines if a direct connection with client computer **102** is to be established, if client computer **102** and changeover bridgeport **165** are not in direct connection with each other. If changeover bridgeport **165** makes the determination not to establish a direct connection between client computer **102** and itself, changeover bridgeport **165** establishes and facilitates the voice call to PSTN extension **143** as described earlier, in step **230**. Additionally, in those cases where changeover bridgeport **165** is not in direct telephony contact with client computer **102**, (i.e., the call is being routed through a number of intermediate servers throughout Internet **150**), changeover bridgeport **165** also monitors the “quality” of the voice call. Any number of metrics known in the art may be beneficially employed to measure the quality of the voice call, e.g. the number of audio packets dropped within a predetermined time interval (Packet Error Rate), the signal to noise ratio, the rise in the measured noise floor, and the like.

If the quality of the voice call is not monitored and the voice call has not been completed, steps **232–234**, changeover bridgeport **165** returns to step **230**. However, if the quality of the voice call is monitored, step **232**, changeover bridgeport **165** further determines if the quality has reached a predetermined threshold and, in addition, whether the user of client computer **102** has previously rejected an offer to switch to a direct connection with changeover bridgeport **165**, step **236**. If the measured quality level is in an acceptable range, or the user has previously rejected an offer to establish a direct connection, changeover bridgeport **165** returns to step **230**. Otherwise, changeover bridgeport **165** prompts the user of client computer **102**

whether the user would like to switch to a direct connection between client computer 102 and changeover bridgeport 165, step 238. If the user of client computer 102 responds with an election not to switch to a direct connection, step 240, changeover bridgeport 165 returns to step 230. However, if the user of client computer 102 responds with an election to switch to a direct connection, step 240, changeover bridgeport 165 causes a direct connection to be established between itself and client computer 102, step 242. Upon establishing the direct connection, changeover bridgeport 165 re-connects the connection between client computer 102 and PSTN extension 143 and continues to facilitate the voice call as described earlier, step 230.

Similarly, if back in step 228, changeover bridgeport 165 makes the determination to establish a direct connection between client computer 102 and itself, the process proceeds to step 238 wherein the user of client computer 102 is offered the opportunity to accept or reject the direct connection between client computer 102 and changeover bridgeport 165. From step 238, the process proceeds as described earlier. Whether changeover bridgeport 165 proceeds to step 230 or to step 238 directly from step 228 will be described in more detail below.

Turning now to FIG. 2C, a flow chart illustrating one embodiment of a method for establishing a direct connection between client computer 102 and the PSTN extension associated with handset 142. In the context of the illustrated embodiment, changeover bridgeport 165 provides software to client computer 102, step 250. The software is a set of instructions containing information necessary to enable client computer 102 to establish a connection with changeover bridgeport 165. Upon receipt of the software by client computer 102, the software tears down the existing data connection between client computer 102 and the ISP currently in direct telephony contact with client computer 102 (e.g., ISP 112), step 252. Having disconnected the prior connection, the provided software initiates a direct connection to changeover bridgeport 165 through the modem of client computer 102, thereby eliminating any intermediate servers, step 254. For the illustrated embodiment, the software is "equipped" with one of changeover bridgeport's PSTN extensions before being provided to client computer 102. Finally, once the direct connection from client computer 102 is established, changeover bridgeport 165 logically "re-links" client computer 102 with PSTN extension 143 for handset 142, step 256, thereby allowing the previously established voice call to be re-connected (although, it should be noted that the physical PSTN connection between the changeover bridgeport and the destination PSTN extension is maintained throughout the direct connect process; rather, it is the data connection between the client computer and the changeover bridgeport that is disconnected and reestablished). In an alternate embodiment, direct connect software may be pre-installed on client computer 102, e.g. as an integral part of client bridgeport application described earlier.

Returning now to step 228 of FIG. 2B, in one embodiment, changeover bridgeport 165 proceeds to step 238 directly, without first monitoring the quality of the voice call, if the changeover bridgeport 165 "knows" a priori that the quality of the voice call will be below an acceptable threshold. For example, assume that it has been determined that the quality of a voice call drops below a predetermined quality level when the number of intermediate servers between a client computer (e.g., client computer 102) and a changeover bridgeport (e.g., changeover bridgeport 165) exceeds a certain number N_2 . Given this example, notwith-

standing the fact that changeover bridgeport 165 was selected as the "best" changeover bridgeport from the "community" of bridgeports, if the actual number of intermediate servers N_1 between client computer 102 and changeover bridgeport 165 exceeds N_2 , changeover bridgeport 165 will know, before the voice call has been established, that the quality of the voice call will be below the acceptable predetermined quality level. In one embodiment, the number of intermediate servers is returned to changeover bridgeport 165 when page bridgeport 162 selects bridgeport 165 as the changeover bridgeport, and registers the voice call with changeover bridgeport 165. In one embodiment, changeover bridgeport 165 preserves the inputs along with the registration information for use at step 228. In another embodiment, bridgeport 165 may retain up to a predetermined number of "bid responses", which will include the number of intermediate servers, for a period of time sufficiently long to ensure that if bridgeport 165 is selected as the changeover bridgeport, the bid response information is available.

In an alternate embodiment, changeover bridgeport 165 proceeds to step 238 directly, without having first monitored the quality of the voice call, if changeover bridgeport 165 was instructed to do so by page bridgeport 162 when page bridgeport 162 selects bridgeport 165 as the changeover bridgeport and registers the voice call. Page bridgeport 162 may select to so instruct changeover bridgeport 165 based on a similar decision process described earlier for the case where changeover bridgeport 165 makes the decision. Alternatively, page bridgeport 162 may do so because it is so instructed by web server 128, through parameters embedded within the Push-To-Talk™ button. In other words, the Push-To-Talk™ button, projected by web server 128, is a "direct quality" Push-To-Talk™ button that inherently includes offering the user of client computer 102 to conduct the voice call via a direct connection at a "direct quality" level.

In summary, page bridgeport 162, in response to a Push-To-Talk™ event notification, solicits inputs and selects a changeover bridgeport 165 from a "community" of bridgeports. The changeover bridgeport 165, in response to the placement of a net call from client computer 102 establishes a PSTN connection to the appropriate PSTN extension and bridge the call. In so doing, client computer 102 may be offered to have the voice call conducted at a "direct quality" level via a direct connection between client computer 102 and changeover bridgeport 165. The offer may be presented dynamically in the middle of the call, at the discretion of changeover bridgeport 165, as it detects the quality of the voice call dropping below an predetermined quality level. Alternatively, the offer may be presented at the beginning of the voice call, at the discretion of changeover bridgeport 165, page bridgeport 162 or web server 128.

Note that except for the solicitation of the concurrence of the user of client computer 102 to switch to a direct connection with changeover bridgeport 165, steps 204-206 are all performed automatically in response to step 202, without requiring any intervention from the user of client computer 102. In particular, it does not require the user of client computer 102 to enter the PSTN extension of handset 142, nor the IP address of changeover bridgeport 165. It does not even require the user of client computer 102 to know this information. All that is required of the user is metaphorically "pushing" the Push-To-Talk™ button projected by web server 128. Furthermore, it should also be noted that the concurrence of the user of client computer 102 is not necessary. For example, in the instance where the direct connection will be toll free, e.g., a local call, or the changeover bridgeport has an "800" access number, or the

toll charge is to be borne by the web server, the Push-To-Talk™ button may be embedded with direct connection software that automatically establishes a direct connection with the changeover bridgeport.

It should also be noted that the voice connection has minimal impact on establishing any additional data connections with any number of web servers **120** and **128**. In other words, client computer **102** may continue to browse webpages offered by web servers **120** and **128**, while simultaneously supporting the voice connection with handset **142** via changeover bridgeport **165**. In addition, although there may be a number of intermediate routers in Internet **150** between changeover bridgeport **165** and client computer **102**, changeover bridgeport **165** is the only server charged with supporting both the voice connection and the H.323 connection, while the voice connection is transparent to the intermediate routers. In other words, the information exchange between changeover bridgeport **165**, through the plurality of intermediate routers of Internet **150**, to client computer **102** will appear as normal data packets to the intermediate routers.

Returning now to the selection of an internet/PSTN changeover server described in step **210**, page bridgeport **162** selects changeover bridgeport **165** from a community of bridgeports. In one embodiment, page bridgeport **162** first solicits input on a number of call characteristics from each bridgeport member of the community. The call characteristics may include the number of intermediate servers (Is) required to connect client computer **102** with the responding bridgeport member, the toll charge (Tc) that may be incurred by placing the telephone call from the responding bridgeport, the bandwidth (B) currently available on the responding bridgeport, the number of PSTN connections (P) supported by the responding bridgeport, service premiums (S), if any, charged by the responding bridgeport, and so forth. In the context of the example implementation, one member bridgeport may respond with an indication that there are no intermediaries between itself and client computer **102** which may provide a higher quality of service, however, given its connection point to PSTN **140**, there may be a significant toll charge incurred in placing the telephone call to handset **142** from this member bridgeport. On the other hand, another member bridgeport may respond with a low toll charge, but with a higher number of intermediaries as the voice data will have to route through a large number of routers.

In any event, for the illustrated embodiment, page bridgeport **162** calculates a Call Metric (CM) for each of the responding bridgeport that is representative of the bridgeports ability to establish and facilitate the voice call between client computer **102** and handset **142**. Equation (1) is an exemplary equation used to calculate the Call Metric for each of the responding bridgeport, wherein the bridgeport with the lowest CM is determined to be able to provide the best all around service. It should be noted that equation (1) is merely illustrative, as one skilled in the art will appreciate that suitable alternative equations may be beneficially employed to calculate alternative call metrics.

$$CM_i = W_1(Is_i) + W_2(Tc_i) + \frac{W_3}{B_i} + \frac{W_4}{P_i} + W_5(S_i) \quad (1)$$

where:

Is number of intermediate servers

Tc toll charge estimate

B available bandwidth on responding server

P number of PSTN ports available on responding server

S premium service charge

W weighting factor

In one embodiment of the present invention, the number of intermediate servers (Is) is determined by each of the responding bridgeports from the community of bridgeports through the use of a “traceroute” function, common to the UNIX network operating environment. As one skilled in the art will appreciate, the execution of a “traceroute” command by a bridgeport will produce a result quantifying the number of intermediate routers between the execution bridgeport and a destination address (provided in the command line). Accordingly, in one embodiment, the execution of the command: “traceroute (IP_address)”, will return a number representative of the intermediate routers required for the responding bridgeport to communicate with the source address, represented by IP_address.

In one embodiment, an estimate of the toll charge is determined locally at the responding bridgeport by accessing a toll rate table stored on the responding bridgeport. An example toll rate table is depicted in Table 1. As illustrated in the example toll rate table of Table 1, an estimate toll charge is determined by analyzing the components of the destination telephone number against a toll charge hierarchy. If none of the elements of the destination telephone number match (i.e., hit) the elements of the toll rate table, a high toll charge estimate is returned. If, however, there is a hit on the area code and the telephone number prefix, a much lower toll charge or even toll free estimate is returned. In alternate embodiments of the present invention, the responding bridgeport may query the local SSP (i.e., the SSP to which it is coupled) to ascertain a specific toll charge value. In such a case, the communication between the responding bridgeport and the local SSP is conducted via an out-of-band signaling protocol such as Signaling System 7 (SS7).

TABLE 1

| TOLL CHARGE LOOKUP TABLE | |
|---------------------------------------|-------------------------------|
| Elements of Destination Telephone No. | Relative Toll Charge Estimate |
| No Hit | \$ \$ \$ \$ |
| Area Code Hit | \$ \$ |
| Area Code and PSTN Prefix Hit | 0 |

In an alternate embodiment, page bridgeport **162** may also involve client computer **102** in the selection of changeover bridgeport **165**, by presenting the solicited responses to the client computer **102**, in even an uncondensed or a condensed format. Whether client computer **102** should be involved in the selection process is a design choice, a trade off between ease of use (without requiring intervention from the user of client computer **102**) and functionality (allowing the user of client computer **102** to veto or influence the selection). Between the two distinct choices, a number of hybrid arrangements can also be made.

It should also be noted that while bridgeport **162** is being described as page bridgeport and bridgeport **165** is being described as changeover bridgeport, being members of a community of bridgeports, a member bridgeport not only may be a page bridgeport at one point in time, and a changeover bridgeport at another time, a member bridgeport actually can be a page bridgeport and a changeover bridgeport at the same time for either the same or different clients. As will be readily apparent from the descriptions to follow, bridgeports **162** and **165** of the present invention can be practiced with computer servers programmed to perform the

above described bridgeport functions, thus it is expected that a bridgeport may be integrated with other equipment in a variety of manners, for examples, with a web server, an ISP, a STP, and so forth.

Turning now to FIGS. 3 and 4, two block diagrams illustrating the hardware and software elements of an exemplary computer server 300 suitable to be employed as a bridgeport are depicted. As illustrated, exemplary computer server 300 is comprised of multiple processors 302a–302n and memory subsystem 308 coupled to processor bus 304 as depicted. Additionally, computer server 300 is comprised of a second bus 310, a third bus 312 and a fourth bus 314. In one embodiment, buses 312 and 314 are Peripheral Component Interconnect (PCI) buses, while bus 310 is an Industry Standard Architecture (ISA) bus. PCI buses 312 and 314 are bridged by bus bridge 316, and bridged to ISA bus 310 and processor bus 304 by I/O controller 306. Coupled to PCI bus 312 are network interface 318 and display interface 320, which in turn is coupled to display 322. Coupled to PCI bus 314 is computer telephony interface (CTI) 324, PSIN interface 326 and SS7 Interface 328. Coupled to ISA bus 310 are hard disk interface 330, which in turn is coupled to a hard drive 332. Additionally, coupled to ISA bus 310. keyboard and cursor control device 334, which in turn is coupled keyboard 336 and cursor control device 338.

CTI interface 324 provides the necessary hardware to interface exemplary computer server 300 to telephony equipment, such as private branch exchange (PBX) equipment. PSTN interface 326 provides the necessary hardware to interface exemplary computer server 300 to a plurality of PSTN communication lines (e.g., T1, E1 or POTS), wherein the actual number of PSTN communication lines interfaced will be implementation dependent. Additionally, PSTN interface 326 provides advanced DSP-based voice, dual-tone multiple frequency (DTMF) and call progress functionality, which allows for downloadable DSP protocol and voice processing algorithms, thereby providing CODEC support locally on the interface. Examples of supported codecs include the Global System for Mobile Communications (GSM) codec and the ITU-T G.723.1 protocol codecs, the specification for which are commonly available from the GSM consortium and the International Telecommunications Union, respectively. Similarly, SS7 interface 328 provides the hardware necessary to interface exemplary computer server 300 with PSTN trunk lines (e.g., ISDN) supporting the out-of-band communication protocol (e.g., SS7) used between PSTN network elements (i.e., SSP-SSP, SSP-STP, STP-SCP, etc.). In one embodiment, PSTN interface 326 is preferably an AG-T1™ (for U.S. implementations, while an AG-E1 may be seamlessly substituted for European implementations), while SS7 interface 328 is preferably the TX3000™, both of which, along with their accompanying software drivers, are manufactured by and commonly available from Natural MicroSystems of Natick, Massachusetts. Otherwise, all other elements, processors 302*, memory system 308 and so forth perform their conventional functions known in the art. Insofar as their constitutions are generally well known to those skilled in the art, they need not be further described.

From a software perspective, FIG. 4 illustrates the software elements of exemplary computer server 300. In particular, exemplary computer server 300 is shown comprising an application layer consisting of a Bridgeport Management Driver 402, Hop Off™⁴ driver 404, and other drivers 406. Hop Off™ driver 404, supported by Management Driver 402, optional drivers 406, and abstracted service layer 408 implements the method steps of FIG. 2 that

are the responsibility of the community of bridgeports (i.e., bridgeports 162, and 165). Accordingly, changeover bridgeport 165 may be referred to as a Hop Off™ bridgeport, in view of its incorporation of Hop Off™ driver 404.

⁴ Hop Off™ is a Trademark of eFusion™, Incorporated of Beaverton, Oreg. The Service Abstraction Layer (SAL) 408 is shown comprising SS7 services 410, CTI Services 411, Management Services 412, Connection Services 414, Streaming Services 416, and Data Services 418. The protocol/service layer is shown comprising Telephony Application Programming Interface (TAPI) 420, Telephony Connection Protocol 422, PSTN Data Interface 424, CODEC 426, Real Time (Streaming) Protocol 428, and HTTP server 434. Also shown in this “layer” are configuration management data 419 maintained by management service 412, and codec services 426 employed by streaming services 416. The driver layer is shown comprising SS7 driver 427, CTI driver 429, PSTN driver 430 and socket service 432. Data and control information are exchanged between these elements in the fashion depicted.

Within the context of the present invention, one purpose of SAL 408 is to provide an Application Programming Interface (API) for all the available bridgeport and related services in exemplary computer server 300. The API abstracts out the actual modules used for providing services such as connection establishment (414), streaming and data exchange services (416 and 418). Additionally, SAL 408 provides the common operation tools such as queue management, statistics management, state management and the necessary interface between the software services (i.e., drivers in the driver layer). SAL 408 is also responsible for loading and unloading the appropriate drivers as appropriate.

Connection service 414 includes a connection establishment and tear-down mechanism facilitating the interconnection to the PSTN 140. Additionally, for the illustrated embodiment, connection service 414 employs connection and compatibility services which facilitate interoperability between communication equipment that support industry standards, thereby allowing a variety of communication equipment manufactured by different vendors to be benefited from the present invention. Connection services 414 include, in particular, services for supporting standard video telephony, such as ITU-T’s H.323 video telephony, and standard data communication, such as ITU-T’s T.120 data communication protocol. Examples of the connection establishment and tear-down mechanisms supported by connection service layer 414 include opening and starting PSTN ports, call control, DTMF collection, and tone generation, to name but a few.

Streaming service 416 is responsible for interfacing with the components that provide the real-time streaming functionality for the multimedia data. Once the connection has been established between the connection points (i.e., PSTN, H.323, etc.), streaming service 416 will take over the management and streaming of data between the two connected parties, until the connection is terminated. CODEC service 426 facilitates the above described compression and transmission of inbound call signals from handset 142 as well as decompression and transmission of outbound call signals from client computer 102.

Data service 418 is responsible for providing non real-time peer to peer (i.e., computer-computer) messaging and data exchange between exemplary computer server 300 and other Internet and perhaps PSTN based applications. Sending messages to exemplary computer server end-points (i.e., other similarly equipped bridgeports on the Internet) or other servers within the PSTN is accomplished via data service 418.

CTI services **411** service all communications and automatic call distribution (ACD) necessary for Private Branch Exchange (PBX) based systems. SS7 services **410** service all out of band communications with STPs and/or SCPs of PSTN **140**.

PSTN driver **430** is equipped to accommodate particularized PSTN interfaces **326**, whereas CTI driver **429** is equipped to support particularized ACD and PBX equipment. Similarly, SS7 driver **427** is equipped to support particularized SS7 interface **328**.

Turning now to FIGS. **5**, **6** and **7**, graphical representations of alternate embodiments of a Push-To-Talk™ indicator for requesting a voice communication session, suitable for use in the exemplary communication system of FIGS. **1–4**, is shown. In FIG. **5**, indicator **500** is a binary prompt embedded in the HTML information for a webpage projected by a web server (e.g., web server **128**), and is selectively actuated by a user to initiate a voice connection with a PSTN extension associated with a handset. In one embodiment, indicator **500** is a Push-To-Talk™ button. In response to a user actuation of Push-To-Talk™ button **500**, a prompt **502** for location information is projected to the user of client computer **102**. In one embodiment, prompt **502** may be a pull-down selection of predetermined locations (e.g., city/state and country locations), wherein the user is requested to make a selection of a location closest to the user. In response to providing the location information, an additional prompt **504** may then be generated which allows the user to set the weighting of different characteristics associated with establishing and facilitating the voice connection (e.g., cost and call quality). In one embodiment, call characteristic prompt **504** includes slide members **506** and **508** which are selectively manipulated by the user of client computer **102** to correspond to “weighting values” (W_i) to be given to, for example, cost and connection quality, respectively.

Alternatively, in FIG. **6**, indicator **600** is shown comprising Push-To-Talk™ button **500** and location information prompt **502**. In response to the coextensive selection of location information and the actuation of Push-To-Talk™ button **500**, an additional prompt **504** may then be generated which allows the user to set the weighting of different characteristics associated with establishing and facilitating the voice connection (e.g., cost and call quality). In the alternate embodiment of FIG. **7**, exemplary indicator **700** is shown comprising Push-To-Talk™ button **500**, location information prompt **502** and call characteristic prompt **504**. In accordance with the coextensive selection of location information and call characteristic information with the actuation of Push-To-Talk™ button **500**, the establishment of a voice connection is initiated in accordance with the method steps of FIGS. **2A–2C**. In alternate embodiments, the location and call characteristic information may be collected from information resident on the client computer at the start-up of the internet telephony software, the bridgeport client application software, or by querying the internet browser application running on the client computer (via a “cookie”).

While the method and apparatus of the present invention has been described in terms of the above illustrated embodiments, those skilled in the art will recognize that the invention is not limited to the embodiments so described. In particular, the present invention may beneficially be implemented in combination with other technology to accommodate a wide variety of communication needs. For example, in one embodiment, the Push-To-Talk™ service instead of being offered by the corporate web server, may be offered by

an independent third party. Accordingly, an intermediate third party server (or bridgeport) other than the web server may “inject” a Push-To-Talk™ button into the information exchange between the web server and the client computer which, when enabled, will initiate a voice call to the local affiliate. Just such an invention is discussed in copending U.S. patent application Ser. No. 08/818,771, entitled “Method and Apparatus for Value Added Content Delivery”, filed contemporaneously herewith and commonly assigned to the assignee of the present application, the disclosure of which is fully incorporated herein by reference. In other communication environments, it may be beneficial for the user of the client computer and the user of the PSTN extension (who also has access to a computer) to view common information on the computer displays while maintaining the voice connection (e.g., a customer service, help desk, sales, etc.). A description of just such an invention is discussed in the U.S. patent application entitled “Method and Apparatus for Synchronizing Information Browsing Among Multiple Systems”, U.S. patent application Ser. No. 08/818,741 filed contemporaneously herewith and commonly assigned to the assignee of the present application, the disclosure of which is fully incorporated herein by reference. In other embodiments, it may be beneficial to provide customized call processing services to the communication environment. Examples of such customized call processing services include providing an automated call attendant service having specialized call processing features. Just such an invention is disclosed in the U.S. patent application entitled “Method and Apparatus for Providing Customized Call Processing”, U.S. patent application Ser. No. 08/818,579 filed contemporaneously herewith and commonly assigned to the assignee of the present application, the disclosure of which is fully incorporated herein by reference. All of the foregoing patent applications are expressly incorporated herein by reference. Thus, the present invention can be practiced with modification and alteration within the spirit and scope of the appended claims. Accordingly, the description is to be regarded as illustrative instead of restrictive on the present invention.

Thus, a method and apparatus for establishing and facilitating a direct quality voice call to a telephone extension on behalf of a client computer has been described.

What is claimed is:

1. A computer system comprising:

a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services on said computer system for establishing and facilitating a voice call to a PSTN extension on behalf of a client computer, the client computer being already communicatively connected to the computer system via a varying plurality of network nodes of a data network, wherein the communication services include services for newly establishing a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate said voice call through said previously established variable data network connection and said newly established first direct PSTN connection, and services for conditionally causing, at a later time during the voice call, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continue to facilitate said voice call through said newly established replacement second direct PSTN

connection and said second earliest established first direct PSTN connection instead, wherein the services for conditionally causing the replacement second direct PSTN connection to be newly established between the client computer and the computer system, include services for monitoring quality of the voice call between the client computer and the PSTN extension while the voice call is being facilitated through said earliest established variable data network connection and the second earliest established first direct PSTN connection, and services for notifying the client computer when the quality of the voice call drops below a predetermined quality threshold while the voice call is being facilitated through said earliest established variable data network connection and the second earliest established first direct PSTN connection; and

an execution unit, coupled to the storage medium, for executing the plurality of programming instructions.

2. The computer system of claim 1, wherein the services for conditionally causing the replacement second direct PSTN connection to be newly established between the client computer and the computer system, include services for causing the replacement second direct PSTN connection to be newly established responsive to the receipt of a confirmation from the user of the client computer confirming that the replacement second direct PSTN connection should be established, while the voice call is being facilitated through said earliest established variable data network connection and the second earliest established first direct PSTN connection.

3. The computer system of claim 1, wherein the services for conditionally causing the replacement second direct PSTN connection to be newly established between the client computer and the computer system, further include services for prompting a user of the client computer for confirmation with respect to the establishment of the replacement second direct PSTN connection between the client computer and the computer system.

4. A computer system comprising:

a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services on said computer system for establishing and facilitating a voice call to a PSTN extension on behalf of a client computer, the client computer being already communicatively connected to the computer system via a varying plurality of network nodes of a data network, wherein the communication services include services for newly establishing a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate said voice call through said previously established variable data network connection and said newly established first direct PSTN connection,

services for conditionally causing, at a later time during the voice call, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continue to facilitate said voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection instead, and

services for providing the client computer with software to newly establish the replacement second direct PSTN connection from the client computer to the computer system; and

an execution unit, coupled to the storage medium, for executing the plurality of programming instructions.

5. The computer system of claim 4, wherein the software is equipped with a PSTN extension of the computer system.

6. The computer system of claim 4, wherein the software is equipped to automatically terminate a current telephony connection of the client computer, and establish the replacement second direct PSTN connection from the client computer to the computer system.

7. A computer system comprising:

a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services on said computer system for establishing and facilitating a voice call to a PSTN extension on behalf of a client computer, the client computer being already communicatively connected to the computer system via a varying plurality of network nodes of a data network, wherein the communication services include services for newly establishing a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate said voice call through said previously established variable data network connection and said newly established first direct PSTN connection, services for conditionally causing, at a later time during the voice call, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continue to facilitate said voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection instead, and

services for prompting a user of the client computer to confirm whether the replacement second direct PSTN connection should be newly established, while the voice call is being facilitated through said earliest established variable data network connection and the second earliest established first direct PSTN connection, before causing said replacement second direct PSTN connection between the client computer and the computer system to be established; and

an execution unit, coupled to the storage medium, for executing the plurality of programming instructions.

8. A computer system comprising:

a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services on said computer system for establishing and facilitating a voice call to a PSTN extension on behalf of a client computer, the client computer being already communicatively connected to the computer system via a varying plurality of network nodes of a data network, wherein the communication services include services for newly establishing a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate said voice call through said previously established variable data network connection and said newly established first direct PSTN connection, and services for conditionally causing, at a later time during the voice call and in response to an instruction from another computer system communicatively coupled to the computer system, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection

between the client computer and the computer system and continue to facilitate said voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection instead; and

an execution unit, coupled to the storage medium, for executing the plurality of programming instruction.

9. A computer system comprising:

a storage medium having stored therein a plurality of programming instructions for implementing a set of communication services on said computer system for establishing and facilitating a voice call to a PSTN extension on behalf of a client computer, the client computer being already communicatively connected to the computer system via a varying plurality of network nodes of a data network, wherein the communication services include services for newly establishing a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate said voice call through said previously established variable data network connection and said newly established first direct PSTN connection, and services for conditionally causing, at a later time during the voice call and responsive to a request from a user of the client computer, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continue to facilitate said voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection instead; and

an execution unit, coupled to the storage medium, for executing the plurality of programming instruction.

10. In a computer system, a method for establishing and facilitating a voice call from a client computer to a public switched telephone network (PSTN) extension, the client computer being already communicatively connected to the computer system through a varying plurality of network nodes of a data network, the method comprising:

newly establishing by the computer system a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish the voice call;

bridging the voice call between the PSTN extension and the client computer through said previously established variable data network connection and said newly established first direct PSTN connection;

providing to the client computer software equipped to automatically and newly establish a replacement second direct PSTN connection between the client computer and the computer system; and

conditionally causing, at a later time during the voice call, the replacement second direct PSTN connection to be established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continuing to bridge the voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection.

11. The method of claim **10**, wherein the provided software is equipped to:

automatically terminate a current telephony connection of the client computer; and

newly establish the replacement second direct PSTN connection from the client computer to the computer system, the software being also equipped with a PSTN extension of the computer system.

12. In a computer system, a method for establishing and facilitating a voice call from a client computer to a public switched telephone network (PSTN) extension, the client computer being already communicatively connected to the computer system through a varying plurality of network nodes of a data network, the method comprising:

newly establishing by the computer system a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish the voice call;

bridging the voice call between the PSTN extension and the client computer through said previously established variable data network connection and said newly established first direct PSTN connection; and

conditionally causing, at a later time during the voice call and responsive to receipt of an instruction from another computer system, a replacement second direct PSTN connection to be established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continuing to bridge the voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection.

13. In a computer system, a method for establishing and facilitating a voice call from a client computer to a public switched telephone network (PSTN) extension, the client computer being already communicatively connected to the computer system through a varying plurality of network nodes of a data network, the method comprising:

newly establishing by the computer system a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish the voice call;

bridging the voice call between the PSTN extension and the client computer through said previously established variable data network connection and said newly established first direct PSTN connection; and

conditionally causing, at a later time during the voice call in response to an instruction from a user of the client computer, a replacement second direct PSTN connection to be established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continuing to bridge the voice call through said newly established replacement second direct PSTN connection and said second earliest established first direct PSTN connection.

14. An article of manufacture comprising:

a recordable medium having recorded thereon a plurality of programming instructions for use to program a computer system to equip the computer system with a plurality of communication services to enable the computer system to be able to establish and facilitate a voice call from a client computer to a public switched telephone network (PSTN) extension, the client computer being already communicatively connected to the computer system through a varying plurality of nodes of a data network, the communication services including services to enable the computer system to be able

23

to newly establish a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate the voice call through the previously established variable data network connection and the newly established first direct PSTN connection, and to be able to conditionally cause, at a later time during the call, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system and continue to facilitate the voice call through the newly established second direct PSTN connection and the second earliest established first direct PSTN connection instead. and services that enable the computer system to be able to provide to the client computer software equipped to establish the replacement second direct PSTN connection.

15. The article of claim 14, wherein the provided software is equipped with a PSTN extension of the computer system.

16. The article of claim 14, wherein the provided software is equipped to automatically terminate a current telephony connection of the client computer, and newly establish the replacement second direct PSTN connection between the client computer and the computer system.

17. An article of manufacture comprising:

a recordable medium having recorded thereon a plurality of programming instructions for use to program a computer system to equip the computer system with a plurality of communication services to enable the computer system to be able to establish and facilitate a voice call from a client computer to a public switched telephone network (PSTN) extension, the client computer being already communicatively connected to the computer system through a varying plurality of nodes of a data network, the communication services including services to enable the computer system to be able to newly establish a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate the voice call through the previously established variable data network connection and the newly established first

24

direct PSTN connection, and to be able to conditionally cause, at a later time during the call and responsive to an instruction of another computer system, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system, and continue to facilitate the voice call through the newly established second direct PSTN connection and the second earliest established first direct PSTN connection instead.

18. An article of manufacture comprising:

a recordable medium having recorded thereon a plurality of programming instructions for use to program a computer system to equip the computer system with a plurality of communication services to enable the computer system to be able to establish and facilitate a voice call from a client computer to a public switched telephone network (PSTN) extension, the client computer being already communicatively connected to the computer system through a varying plurality of nodes of a data network, the communication services including services to enable the computer system to be able to newly establish a first direct PSTN connection from the computer system to the PSTN extension on behalf of the client computer to establish and facilitate the voice call through the previously established variable data network connection and the newly established first direct PSTN connection, and to be able to conditionally cause, at a later time during the call and responsive to a request of a user of the client computer, a second direct PSTN connection to be newly established between the client computer and the computer system to replace the earliest established variable data network connection between the client computer and the computer system, and continue to facilitate the voice call through the newly established second direct PSTN connection and the second earliest established first direct PSTN connection instead.

* * * * *